The Use of Antioxidants in Dry Dog Food[a,b,c]

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The effectiveness of various antioxidants in stabilizing mixes of a dry dog food with inedible grade animal fats was investigated. Certain antioxidants of the hindered phenolic types were most effective in providing stability in dry dog food containing added fat.

A project was initiated in which it was desired to incorporate added levels of inedible grade animal fats into dry dog food. Due to the ever present problem of rancidity, it was considered desirable to investigate means of stabilizing dry dog food-fat mixtures against oxidative rancidity.

Because of the known increase in the stability of crackers, pastries, etc., which can be gained through the use of fats to which certain antioxidants have been added *(1, 3),* this investigation attempted to elucidate the effectiveness of various antioxidants in stabilizing the animal fat which was to be incorporated into the dry dog food, and their effectiveness in stabilizing the fat-meal mixes.

The Schaal oven stability results obtained for the rations prepared in this study lacked precision; the latter fact, together with the fact that the Schaal oven method lacks an objective criterion by which rancidity is ascertained, prompted the development of a rapid and precise method for determining the relative stabilities of "dry" food materials which contain 5% or more of fat *(4)*.

This stability test is based upon the semi-quantitative detection of an accelerated appearance of carbonyl compounds in the gases exhausted from a meal sample undergoing accelerated oxidation at a time when rancid odors are organoleptically detectable.

The relative stabilities of several rations were determined by both the Schaal oven and "carbonyl" method. It was in the latter study *(4)* that the utility of the "carbonyl" method became apparent.

EXPERIMENTAL PROCEDURE

All rations containing added levels of fat were prepared in the following manner:

A commercial dry dog food[d] was ground in a hammer mill equipped with a screen with apertures of 3/32 in. diameter.

Stabilized fat was prepared by adding a solution of antioxidant in 95% ethanol to the hot (80° C.) fat. The addition of the antioxidant was followed by stirring vigorously for a period of 2 minutes.

To 1 kg. of the ground meal was added 60 or 100 g. of the desired fat which was previously warmed to 80° C. A minimum amount of hand mixing was used to disperse the fat throughout the meal. Hand mixing was followed by a 4-minute high speed mixing period with a Hobart Model A-200 mixer equipped with a wire beater.

Eight 25 g. samples of each mix were weighed into 4-oz. screw-cap jars; 4 samples were placed in room storage (26.7° C.) and 4 samples in a Schaal oven (62.8° C.). The remaining sample was placed in 2 glassine lined paper bags and put into room storage. The samples were examined periodically for the odors characteristic of rancidity. Rancidity was also determined in some tests by the "carbonyl" method.

RESULTS AND DISCUSSION

Results of the study conducted to test the effectiveness of various antioxidants in stabilizing inedible grade animal fats appear in Table 1.

TABLE 1

The effectiveness of antioxidants in stabilizing inedible animal fats and fat-dog-meal mixes

Antioxidant Added	A.O.M. Stability Hours (P.V. = 20)		Oven Stability 63° C. (Days) Feed with 10% Added Fat	
	B White Grease	Special Tallow	B White Grease	Special Tallow
Control	10	82	23	29
0.01% B.H.A.	48	530	....	....
0.01% B.H.A. 0.004% C.A.[f]	95	490	33	31
0.01% P.G.	56	808	....	....
0.01% P.G. 0.004% C.A.	64	675	27	30
0.01% p-OH-D.P.A.	378	>1150	....	....
0.01% p-OH-D.P.A. 0.004% C.A.	608	>1150	32	31

[f] C.A. = Citric Acid, P.G. = Propyl Gallate, p-OH-D.P.A. = p-hydroxydiphenylamine, B.H.A. = Butylated Hydroxyanisole.

All of the antioxidants cited showed a great degree of effectiveness in increasing the Active Oxygen Method (A.O.M.) stability *(2)* of the B White grease and Special tallow studied. However, citric acid, when used in combination with the antioxidants listed, imparted stabilities greater than those obtained with antioxidant alone. The lack of synergistic activity of citric acid with antioxidants in the tallow and the exceptionally great synergism exhibited with BHA in the grease are not compatible with experience with other fats and deserve further investigation.

Schaal oven stability results, also reported in Table 1, indicate that when portions of a B White grease and Special tallow stabilized with the same antioxidants were added to a dry dog food, those antioxidants which were the most effective in stabilizing the fats were no more effective in imparting additional stability to the fat-meal mix than were the less effective

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[c] Presented at the Twelfth Annual Meeting of the Institute of Food Technologists, Grand Rapids, Michigan, June 8-18, 1952.

[d] Gaines meal, purchased from the Gaines Dog Food Division, General Foods Corporation, Kankakee, Illinois.

[e] It is realized that conclusions drawn from the findings discussed here cannot be applied generally since the tests were all made on one product. Differences in formulation, differences in quality of ingredients, and even seasonal differences in character of ingredients may introduce factors which will influence antioxidant effectiveness in a specific product.

antioxidants. It was of interest to note that while the tallow had an A.O.M. stability both with and without antioxidant far in excess of that of the grease, the stability of the feed with added fat was generally little different with the 2 fats. The greatest deviation was noted when no antioxidant was in the system.

In another study, rations were prepared, and their Schaal oven and room storage stabilities determined to test the effect of varying the concentration of added fat, the concentration of several antioxidants in the fat to be added to the meal, and of citric acid, when used in combination with other antioxidants, on the stability of the ration.

The room storage tests were inconclusive because all of the rations tested possessed stabilities of one year or more; during that time the rations became infested with meal moths before they became rancid.

Representative data obtained from the Schaal oven studies conducted with the aforementioned objectives appear in Table 2; from these data, the following conclusions, verified in all the cases studied, can be drawn:

(a) The stability of the ration containing added fat, with or without antioxidants, was always greater than the stability of the original meal.

(b) The rations prepared with unstabilized fat added at the 6% level were more stable than those prepared with fat added at the 10% level.

TABLE 2

The effect of varying antioxidant concentration on the Schaal oven stability of a dry dog food [g] with added choice white grease [h]

Antioxidant Used	Oven Stability 63° C. (Days) 6% Grease Added	Oven Stability 63° C. (Days) 10% Grease Added	Antioxidant Used	Oven Stability 63° C. (Days) 6% Grease Added
Control	49	43	0.02% Ionol	48
0.01% B.H.A.	43	48	0.01% Ionol 0.01% C.A.	41
0.02% B.H.A.	54	51	0.01% AO-2246	48
0.01% B.H.A. 0.004% C.A.	40	...	0.02% AO-2246	52
0.01% B.H.A. 0.01% C.A.	29	37	0.01% N.D.G.A.	47
0.02% B.H.A. 0.004% C.A.	44	....	0.01% 2-MeO-Hq.	45
0.02% B.H.A. 0.01% C.A.	46	29	0.01% p-OH-D.P.A.	42
0.01% Ionol	44	....	0.01% p-OH-D.P.A. 0.004% C.A.	44

[g] Original Peroxide Value (O.P.V.) of meal fat = 3, Schaal oven stability = 23 days.
[h] O.P.V. = 6, A.O.M. stability = 3 hours.
Ionol = 2,6-Di-tert-butyl paracresol.
AO-2246 = 2,2'-methylenebis-4-methyl-6-tert-butylphenol.
N.D.G.A. = Nordihydroguariaretic acid.
2-MeO-Hq = 2-methoxyhydroquinone.

The observed diminution in the stabilities of the rations prepared with antioxidant fortified greases added at the 6% level was entirely out of keeping with the known antioxidant properties of the compounds investigated. The negative effects can be attributed, in part, to the lack of precision in obtaining the Schaal oven stability results. Thus, of the 88 individual stability results used to calculate the mean stabilities reported in Table 2, 23, or 26% of those results differed from the mean by 10% or more. Musty odors which were prevalent in many of the ration series studied, and which often impaired the determination of organoleptic rancidity, undoubtedly contributed to the observed lack of precision.

Table 3 shows data obtained in an attempt to determine whether the dry dog food used in the preparation of the fat-meal mixes contained constituents which limited the effectiveness of the antioxidants in preventing rancidity. Rations containing

TABLE 3

The effectiveness of several antioxidants in extracted dry dog food with 10% added choice white grease [j]

Antioxidant Used	Oven Stability 63° C. (Days)	Antioxidant Used	Oven Stability 63° C. (Days)
Control	15	0.02% Ionol	85
0.02% B.H.A.	101	0.02% AO-2246	46
0.02% B.H.A. 0.004% C.A.	93	0.02% N.D.G.A.	17
0.02% P.G.	21	0.02% p-OH-D.P.A.	17
0.02% P.G. 0.004% C.A.	18		

[j] F.F.A. = 1.2%, O.P.V. = 2, A.O.M. Stability = 8½ hours.

9.1% fat were prepared by mixing meal, which had been extracted with petroleum ether (30-60° B.P.), with a Choice White grease fortified with antioxidants.

In sharp contrast with the results reported in Table 2, all of the antioxidants studied, when incorporated into the added grease, afforded some increase in the ration's Schaal oven stability.

The study conducted with the extracted meal exemplified the following facts: (a) The most effective antioxidants [1] were the hindered phenolics, B.H.A., Ionol, and A.O.-2246 in decreasing order of effectiveness. Propyl gallate, N.D.G.A. and p-hydroxydiphenylamine afforded relatively small increases in ration stability.

(b) The dry dog food studied contained petroleum-ether extractable constituents which limited the amount of stabilization that could be gained by the incorporation of antioxidants in the added fat.

In conducting the foregoing work, the need for a rapid, objective, and precise test for the relative stabilities of the prepared rations was apparent. Moreover, a more accurate appraisal of the effect of varying the concentration of antioxidants, and

[1] B.H.A. = Butylated hydroxyanisole; Ionol = 2,6-Di-tert-butyl paracresol; A.O.-2246 = 2,2-methylenebis-4-methyl-6-tert-butylphenol; N.D.G.A. = Nordihydroguariaretic acid.

TABLE 4

The relative stabilities of dry dog foods determined by the "carbonyl" and Schaal oven methods

Description of Sample	"Carbonyl" Stability (Hours)	Oven Stability 63° C. (Days)	Description of Sample	"Carbonyl" Stability (Hours)	Oven Stability 63° C. (Days)
Ground Dry Dog Food	29½	20	0.01% Ionol	36¼	26
Grease [k] 5% Added [l]	30	21	0.02% Ionol	35	25
0.01% B.H.A.	33	21	0.01% Ionol 0.004% C.A.	34	26
0.01% B.H.A. 0.004% C.A.	32¼	16	0.01% AO-2246	35¼	25
0.01% B.H.A. 0.008% C.A.	34½	19	0.02% AO-2246	37	28
0.02% B.H.A.	35½	35	0.01% AO-2246 0.004% C.A.	34¾	26
0.02% B.H.A. 0.004% C.A.	36¾	33	10% Grease Added [m]	27¾	22
0.02% B.H.A. 0.008% C.A.	37½	36	0.01% B.H.A. 0.004% C.A.	32	34
0.01% P.G.	31½	20	0.02% B.H.A. 0.004% C.A.	37½	36
0.02% P.G.	32¼	26	0.01% P.G.	28½	19
0.01% P.G. 0.004% C.A.	35¾	30			

[k] Choice white grease. [l] Control for samples with 5% grease added. [m] Control for samples with 10% grease added.

of citric acid on the stabilities of the rations prepared with unextracted meal could not be made unless a test possessing the above characteristics could be devised.

After the development of the "carbonyl" method *(3)*, the effect of varying the concentration of several antioxidants and of citric acid when used in combination with other antioxidants on the stability of the fat-meal mixes were re-investigated. The results of the re-investigation appear in Table 4.

In contrast with the data presented in Table 2, those obtained using the "carbonyl" method to assess the relative stabilities of fat-meal mixes showed that all of the antioxidants studied increased the stability of the fat-meal mix except in the case of sample No. 109 which contained added grease treated with 0.01% propyl gallate. Increasing the antioxidant concentration from 0.01% to 0.02% increased the "carbonyl" stability in all cases except when Ionol was used; increasing the citric acid concentration, when used with B.H.A. and propyl gallate but not with Ionol, or A.O.-2246, gave a ration stability slightly greater than that obtained with antioxidant alone.

Again, several anomalous Schaal oven results were obtained in this study comparing the "carbonyl" and Schaal oven stabilities. However, it can be observed that although no exact numerical correlation was found to exist between the stabilities assessed by the two methods, the results do indicate that the same trends which occur in the Schaal oven data also occur in the data obtained by the "carbonyl" method. The utility of the "carbonyl" method for practical accelerated testing of dry dog food was well established in this study.

SUMMARY

The effects of antioxidants in stabilizing dry dog food containing added inedible grades of animal fat have been investigated. Schaal oven and room storage tests indicated that added levels of unstabilized, inedible grade animal fats did not have deleterious effects on the stability of a dry dog food.

Materials present in the petroleum ether extractable portion of the dry dog food limited the effectiveness of the antioxidants studied in protecting the fat-meal mixes against oxidative rancidity.

Phenolic antioxidants of the hindered or partially hindered type appear to be the most effective for stabilizing the fats in a complex system such as dry dog food.

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